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CALOPHYA TRIOZOMIMA SCHWARZ, A SUMAC-FEEDING PSYLLID NEW TO THE EASTERN UNITED STATES (HOMOPTERA: PSYLLOIDEA: CALOPHYIDAE)

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Abstract.—*Calophya triozomima* Schwarz, known previously from Alberta, Arizona, California, Colorado, Idaho, Missouri, and Utah, is reported from the eastern United States. It was collected on native and ornamental fragrant sumac (*Rhus aromatica* Ait.) in Connecticut, Kentucky, Indiana, Maryland, Michigan, New York, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia, and Wisconsin. Eastern records are listed and mapped, observations on seasonal history and habits are summarized, and recognition features and illustrations of adult habitus and wing venation are provided. Although eastern populations could be adventive, this psyllid is considered indigenous in the eastern United States.

Key Words: Psyllids, distribution, faunal origin, *Rhus aromatica*, pest potential

The genus *Calophya* Löw (Calophyidae) is a large, predominantly North Temperate group of psyllids feeding primarily on plants in the family Anacardiaceae (Hodkinson 1980). It is placed in the nominotypical subfamily Calophyinae, a lineage considered monophyletic by White and Hodkinson (1985). The Calophyinae contain five genera of which *Calophya* is the largest with species in the Holarctic and Neotropical regions. Most hosts of *Calophya* are in the Rutales (Burseraceae, Rutaceae, and Anacardiaceae), but species have been reported from *Phoradendron* (Loranthaceae, Santalales) and *Idria* (Fouquieriaceae, Violales) (Hodkinson and White 1981). *Calophya* currently contains five South American and 14 North American species (Hodkinson and White 1981, Hodkinson 1988). Four species have been previously reported from the eastern United States, but only *C. flavida* Schwarz and *C. nigripennis* Riley have been collected east of Illinois and north of Florida (*C. pallidula* McAtee was described from Illinois, and *C. arcuata* Caldwell is found in Florida).

Like most psylloids, species of *Calophya* are narrowly host specific, with the Holarctic species specializing on sumac, *Rhus* (Anacardiaceae) (Hodkinson 1974). *Calophya flavida* feeds on smooth sumac (*R. glabra* L.) and *C. nigripennis* is found on dwarf sumac (*R. copallina* L.) (Crawford 1914, McAtee 1918). Most species of *Calophya* from the western United States have hosts in *Rhus* subgenus *Lobadium* (which contains *R. aromatica* Ait.), including *C. aurea* Tuthill, *C. californica* Schwarz, *C. dubia* Crawford, *C. nigrella* Jensen, and western populations of *C. triozomima* Schwarz.

Our recent collecting has produced the first records of *C. triozomima* from the eastern United States. Herein we list new records, map the known eastern distribution,

Fig. 1. Distribution of *Calophya triozomima* in the eastern United States. Dots = new records; circle = previous easternmost record.

and give notes on its habits and seasonal history on fragrant sumac (*R. aromatica*). Recognition features and illustrations of adult habitus and wing venation are provided. Neither *C. flavida* nor *C. nigripennis* were collected from *R. aromatica* during the course of this study.

Distribution

Schwarz (1904) described *C. triozomima* from southern Arizona and Los Angeles Co., California. Paratypes from Arizona (Oracle and Santa Rita Mountains, as cited by Crawford [1914]) were collected on *R. trilobata* (Nutt.) Gray (for discussion of the status of *R. trilobata,* see "The Host Plant"). Crawford (1914) recorded *C. triozomima* from Colorado and described the new variety *claripennis* from Arizona and Colorado. Subsequent records have been west of the Mississippi River: Idaho (Klyver 1932), Alberta (Strickland 1939), Utah (Jensen and Knowlton 1951), and Missouri (Craig 1973). The host for the Columbia, Missouri, collection was *R. aromatica.*

The following records, all from *R. aromatica,* document the presence of *C. triozomima* in the eastern states (Fig. 1). Voucher specimens from our field work have been deposited in the collections of the Carnegie Museum of Natural History, Pittsburgh (CMNH); Cornell University, Ithaca, New York (CUIC); and Pennsylvania Department of Agriculture, Harrisburg (PDA). The Wisconsin record is based on a specimen in the Entomological Collections of the Natural History Museum (USNM), Beltsville, Maryland.

CONNECTICUT: *Middlesex Co.,* Wesleyan University, Middletown, 15 July 1989, A. G. Wheeler, Jr. (AGW). **INDIANA:** *Tippecanoe Co.,* Purdue University, West Lafayette, 6 July 1986, T. J. Henry and AGW. **KENTUCKY:** *Jessamine Co.,* Camp Nelson, Boone's Bluff, 20 April 1991, AGW. **MARYLAND:** *Allegany Co.,* Fifteen Mile

Creek Road, Green Ridge State Forest, 30 June 1991, AGW; N. of Flintstone, 19 Aug. 1991, AGW. **MICHIGAN:** *Chippewa Co.,* Maxton Plains, Drummond Island, 20 July 1991, AGW. **NEW YORK:** *Tompkins Co.,* Cornell University, Ithaca, 12, 24 & 27 May 1990 and 17 March & 4 Aug. 1991, AGW. **OHIO:** *Ottawa Co.,* Marblehead Peninsula, near Lakeside, 8 Aug. 1992, AGW. **PENNSYLVANIA:** *Bedford Co.,* Shawnee State Park, S. of Schellsburg, 9 & 17 May, 13 June 1990, 10 Aug. 1991, AGW; *Cumberland Co.,* Cave Hill, Carlisle, 29 July 1990, 5 & 13 May and 18 Aug. 1991, AGW; *Fulton Co.,* shale barren E. of Harrisonville, 29 July 1990, AGW; *Huntingdon Co.,* Hawns Bridge shale barren, S. of Huntingdon, 16 May 1989, J. E. Rawlins and AGW (Host Voucher in Carnegie Herbarium, Thompson No. 8370); *Juniata Co.,* limestone glade S. of McAlisterville, 10 May & 21 June 1990, 20 May 1991, AGW. **TENNESSEE:** *Davidson Co.,* Long Hunter State Recreation Area, 19 April 1991, AGW. **VIRGINIA:** *Frederick Co.,* Highway I-81 at junction with Route 672 near Clear Brook, 11 May & 16 Aug. 1991, AGW; *Pulaski Co.,* Route 100 at junction with Highway I-81 S. of Dublin, 5 May, 10 & 27 June 1991, AGW; *Shenandoah Co.,* shale barren, base of Short Mountain, SE of Mount Jackson, 11 May 1991 & 4 Sept. 1992, AGW. **WEST VIRGINIA:** *Berkeley Co.,* Yankauer Nature Preserve, c. 6 mi. NE of Martinsburg, 30 April 1990, AGW. **WISCONSIN:** *Jefferson Co.,* Waterloo, 14 July 1961, W. E. Simmons.

The Host Plant

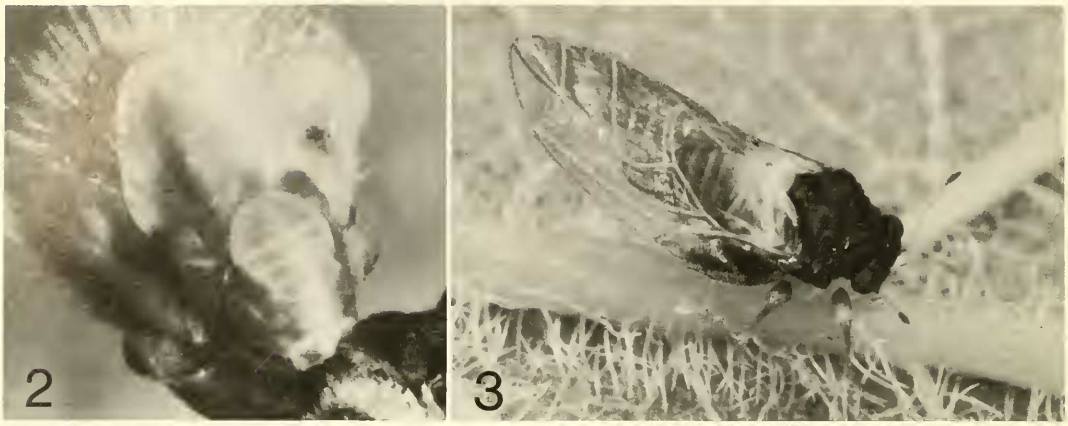
Rhus aromatica is a straggling or upright shrub that grows to a height of about 2 m. It often forms thickets and has ascending lower branches. Leaves are trifoliate and resemble those of poison ivy, *Toxicodendron radicans* (L.) Kuntze. They are coarsely toothed and usually glossy on the upper surface. Flowers are polygamous or dioecious, yellow, catkinlike before opening, and appear in March or April before the leaves unfold. The bright red fruits are densely pubescent. Ranging from southern Ontario and Quebec south to Florida and west through the Great Lakes region, Alberta, and Oregon south to California, Texas, and Mexico, this highly variable plant grows in dry rocky or sandy soils (Fernald 1950, Gleason and Cronquist 1991).

Rhus aromatica and *R. trilobata* were placed in *Rhus* subgenus *Lobadium* section *Lobadium* by Barkley in his classic monograph of North American sumacs (Barkley 1937). Young (1978), using morphological features, wood anatomy, and flavonoid chemistry, grouped the *R. aromatica-R. trilobata* complex with the other deciduous species in the subgenus *Lobadium*: *R. allophylloides* Stanley, *R. schmideloides* Schlecht, and *R. microphylla* Engelm. ex A. Gray. Kartesz and Kartesz (1980) listed *R. aromatica* and *R. trilobata* as distinct species, but we note that the latter has been treated recently as one of several western varieties of *R. aromatica* (e.g. McGregor 1986, Looman and Best 1987, Welsh et al. 1987; see also Gleason and Cronquist 1991). The distribution given above includes that of varieties formerly referred to *R. trilobata.*

Rhus aromatica is used as an ornamental plant for its dense, glossy foliage that turns orange or scarlet in fall; several cultivars have been developed. It is useful for providing quick growing cover, especially on sunny slopes (Dirr 1975, Everett 1982).

Habitats

We encountered *C. triozomima* in several specialized habitats. At the Hawns Bridge Barrens Natural Area in Huntingdon Co., Pennsylvania, it was found on fragrant sumac growing on sheer cliffs overlooking Raystown Lake. This is a small barren of southwest-facing slope and thin soil overlying Devonian bedrock. Lying at the northern limit of the mid-Appalachian shale barrens, it lacks most of the endemic plants characteristic of shale barrens in southwestern Virginia and adjacent West Virgin-



Figs. 2–3. *Calophya triozomima* feeding on fragrant sumac, *Rhus aromatica*. 2. Overwintering nymph. 3. Adult in late spring.

ia (Keener 1983). The collections in Fulton Co., Pennsylvania, Allegany Co., Maryland, and Shenandoah Co., Virginia, are also from shale barrens. In other native stands of fragrant sumac in Pennsylvania, *C. triozomima* was taken in a small limestone glade in Juniata Co. and on limestone bluffs overlooking the Conodoguinet Creek in Cumberland Co. The psyllid also was found at the edge of a cedar (or limestone) glade in Central Tennessee, in a remote natural area on Drummond Island in Michigan, from an old quarry in what formerly was limestone prairie in Ohio, and from native plants growing above Fall Creek Gorge on the Cornell University Campus in Central New York.

In landscape plantings, the psyllid was collected on the campuses of Purdue University in Indiana, Wesleyan University in Connecticut, and along two major highways in Virginia. Its abundance on cultivated fragrant sumac appeared greater than in most populations in the wild, possibly because the dense ornamental plantings offer a more abundant food resource than the generally sparse native stands.

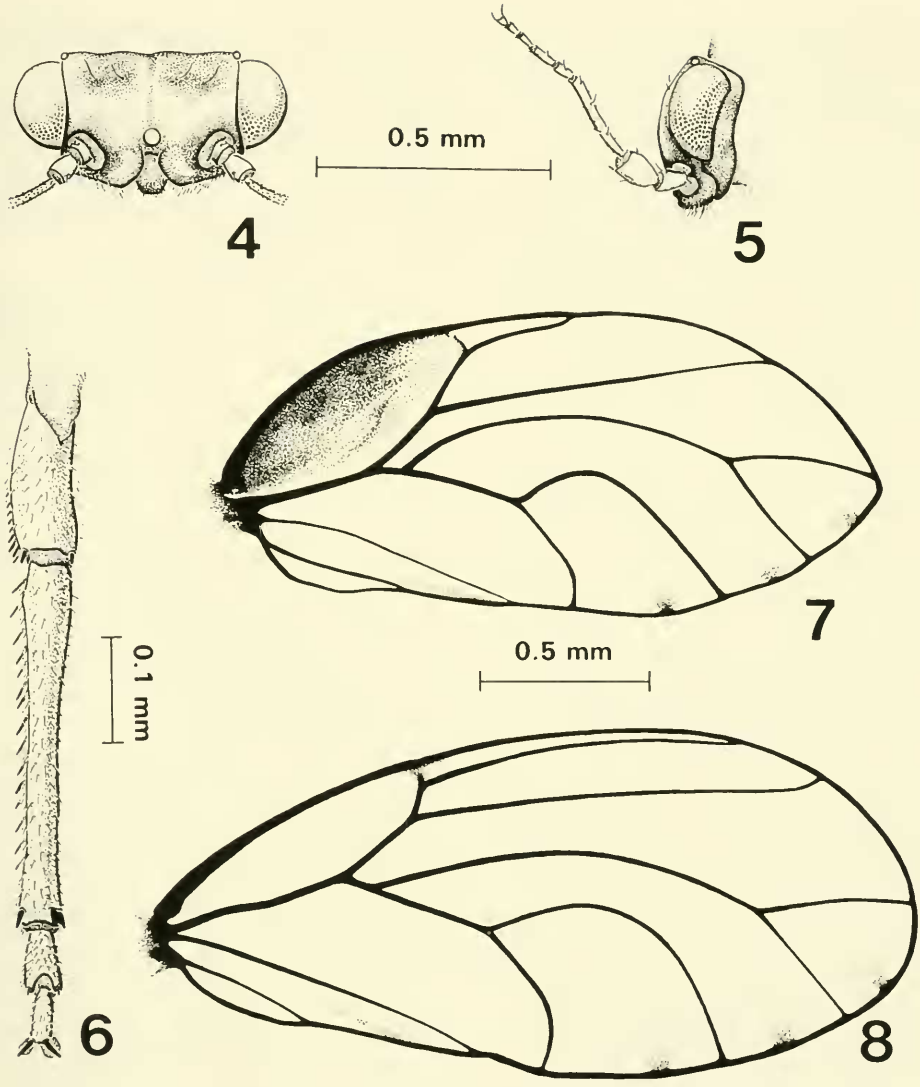
Seasonal History and Habits

These notes on habits and seasonality represent a composite of observations made at several localities. The seasonality profile was inferred by contrasting intervals when adults were observed (usually during periods of peak abundance) with those when no adults could be collected. Regular sampling of a population throughout the season is needed to obtain a better understanding of its life history.

Overwintering occurs as late-instar nymphs appressed to stems at the axil of a leaf bud and twig, the base of buds, and on bracts of the aments or catkins (Fig. 2). As temperatures warm in spring, they are found on leaf buds and catkins. Adults were present by late April in Kentucky and Tennessee, and teneral adults were collected in late April in West Virginia's eastern panhandle and in early May in Pennsylvania. At Ithaca, New York, only nymphs were found on 12 and 24 May 1990, but adults were present by 27 May.

Adults were observed on leaves and stems and also clustered around buds (Fig. 3). Overwintered adults had disappeared by late May in more southern populations, and first generation adults were present by late June. At most sites, they persisted through July. The large numbers of adults observed during the first half of August apparently represented a second generation.

The bivoltine life cycle of *C. triozomima* contrasts with the univoltinism of *C. nigri-*



Figs. 4–8. Adult structures of *Calophya*. 4. *C. triozomima*, anteroventral view of head. 5. *C. triozomima*, lateral view of head. 6. *C. triozomima*, metathoracic leg showing absence of darkened spines at apex of basal tarsomere. 7. Left forewing of *C. triozomima*. 8. Left forewing of *C. flavida*.

pennis on dwarf sumac. Like *C. triozomima*, it overwinters as nymphs, and adults begin to appear in spring (mid-May in southern New Jersey). However, eggs do not hatch until mid- to late June, and each of the first three nymphal stages lasts about a month. Development in *C. nigripennis* therefore has been characterized as "very slow" (Weiss 1918, Weiss and Nicolay 1918).

Recognition Characters

Species of *Calophya* in the eastern United States may be recognized by the rounded vertex that is neither flattened nor extended anteriorly (Fig. 4), by the absence of dark, modified spines at the distal end of the basal tarsal segment of the hind legs (a feature characteristic of several other northeastern psylloids) (Fig. 6), by forewing venation with the medial and cubital veins stalked and not

arising at the same point as the radial vein (Figs. 7, 8), and by moderately developed genal cones that do not (or barely) cover the frons on the midline (Fig. 5).

Adults of the typical morph of *C. triozomima* are easily distinguished from sympatric congeners in the East by their transparent forewings bearing a diffuse, darkened spot on the anterior basal cell (Fig. 7), and their brown to black thoraces (Fig. 3). The forewings are entirely darkened in *C. nigripennis,* and the body is light yellow to orange throughout in *C. flavida.* Pale yellow individuals of *C. triozomima* (variety *claripennis* Crawford) lack the dark spot at the base of the forewing, and may be distinguished from *C. flavida* by the apex of the forewing, which is subacute in *C. triozomima* (Fig. 7) and broadly rounded or slightly angled in *C. nigripennis* and *C. flavida* (Fig. 8). Adult psylloids with dark thoraces and transparent wings on fragrant sumac in the eastern United States are most likely *C. triozomima.* Specimens referable to the *claripennis* phenotype are apparently rare in the eastern United States as only a few females taken in Huntingdon Co., Pennsylvania, match the varietal description.

A second, possibly undescribed (and univoltine) species of the genus often co-occurs with *C. triozomima* on fragrant sumac in the East. We are attempting to determine the identity of this small, pale yellow *Calophya,* one that will be misidentified as *C. flavida* using available literature.

Last-instar nymphs of *C. triozomima* are best identified by association with adults, but can be recognized as calophyine by the following combination of characters: antennae less than half the length of the forewing pads; scales or enlarged, bladelike setae (sectasetae) absent on the margins of the abdomen and forewing pads; sectasetae present on the antennae (White and Hodkinson 1985).

Discussion

That *C. triozomima* has long been known only from western North America suggests it is not native in the East. Its recent detection on the Cornell University campus where the insect fauna has been reasonably well studied for more than a century supports such a conclusion. Its presence on ornamental fragrant sumac on college campuses and along highways could indicate an introduction with nursery stock.

But *C. triozomima* could well be indigenous in the East. It develops on a relatively inconspicuous shrub that entomologists could easily overlook. Or potential collectors might avoid this plant because its foliage looks so much like that of poison ivy. In addition, fragrant sumac often grows on steep slopes that limit accessibility to collectors. Indeed, the occurrence of psyllids in several remote, undisturbed areas points to an indigenous status in eastern North America. We acknowledge, however, that some vagile immigrants disperse rapidly and are able to colonize habitats well removed from their area of entry.

We consider this psyllid native to the eastern states because of its association with a host plant unlikely to draw attention from entomologists, because the Psylloidea in general have not been well collected, and because certain Lepidoptera taken with the psyllid at the Hawns Bridge shale barren are mainly western species that also are poorly known or have gone unnoticed in the East (J. E. Rawlins, unpublished data).

The pest potential of *C. triozomima* is uncertain. Johnson and Lyon (1988) mentioned *C. californica* Schwarz as a pest of *Rhus ovata* S. Wats. in California. The Neotropical *C. schini* Tuthill, discovered in California in 1984, has become a pest of California pepper tree, *Schinus molle* L. Nymphs develop within pits they induce on pepper tree leaflets and cause foliar pitting, discoloration, and distortion. Cessation of growth and loss of foliage also are possible (Downer et al. 1988, Johnson and Lyon 1988). Although *C. triozomima* appears not to cause such noticeable injury, we have observed some leaflet distortion on fragrant sumac. Dwarf sumac heavily infested with

C. nigripennis shows discoloration of foliage and disfiguration of upper leaf surfaces (Weiss 1918, Weiss and Nicolay 1918). We conclude that large populations of *C. triozomima* sometimes developing on cultivars of *R. aromatica* in landscape plantings should be considered potentially injurious.

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